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WATER CONSERVATION FOR AGRICULTURE IN NORTHWEST CHINA

/Summary: This report summarizes Chapters II through IX of the Chinese monograph, Agricultural Water Conservation in the Northwest by Wang Ch'eng-ching. It discusses the irrigation systems, ancient and modern, of the six arid northwestern provinces of Shensi, Suiyuan, Ningsia, Kansu, Tsinghai, and Sinkiang where the annual rainfall ranges from 4 to 850 millimeters. Twenty-one tables give information on location and equipment of irrigation facilities, sources of water, and areas benefited. The report also discusses prospects and requirements for expansion of irrigation in the various provinces. Table 21 gives some crop production data, for Shensi./

A. Geographical Basis of Irrigation in the Northwest

Because of its inland location, surrounded by mountains, the Northwest is an area of light rainfall, ranging from almost none to about 850 millimeters per year. The distribution of rainfall is indicated by the following table.

Table 1. Annual Rainfall and Evaporation in Various Cities

Province	City	Annual Rainfall (mm)	Years	Evaporation (mm)
Shensi	Nan-cheng	841.3	1936 - 1940	--
	T'ung-kuan	670.8	1937 - 1940	1,423.4
	Sian	557.2	1923 - 1940	879.3
	Ching-yang	474.5	1925 - 1940	--

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Province	City	Annual Rainfall (mm)	Years	Evaporation (mm)
	Yü-lin	422.7	1936, 1937	--
Suiyuan	Kuei-sui	374.1	1920 - 1937	--
	Sa-la-ch'i	324.1	1920 - 1937	--
	Pao-t'ou	409.8	--	1,409
Ningsia	Yin-ch'uan	148.2	1936, 1937	1,606.7
	Chin-chi	236.2	--	1,511.3
Kansu	Lan-chou	306.9	1933 - 1940	1,355.1
	Chang-yeh	95.2	1938 - 1940	--
	Chiu-ch'uan	79.1	1935 - 1940	--
	Tun-huang	31.8	1938 - 1940	--
Tsinghai	Hsi-ning	364.5	1937 - 1940	--
	Hua-lung	296.1	1937 - 1940	--
Sinkiang	Urumchi	228.8	1937 - 1943	--
	T'a-ch'eng	274.2	1941 - 1943	--
	K'u-ch'e	75.8	1928 - 1931	--
	Tu-lu-fan	29.2	1938 - 1943	--
	Ch'o-ch'iang	4.5	1928, 1929	--

B. Irrigation in Shensi

The Kuan-chung plain, Shensi, ranges from 12 Chinese li wide in the west at Pao-chi to 40-50 kilometers wide between Sian and Tung-kuan. The soil is an alluvial and wind borne loess.

Unfortunately, since it lies north of the Tsinling Shan, the rainfall on this fertile plain is insufficient for agriculture (from 400 to 800 millimeters per year) and 65 percent of what rain there is comes in the autumn. Hence irrigation is carried on on a large scale in the area and has been since the time of Ch'in Shih-huang /221 - 207 BC/.

The following modern type irrigation projects have been undertaken in Shensi in recent years:

Table 2. Modern Irrigation Canals in Shensi

Canal	River	Hsiens	Irrigation Area (shih-mou*)	Length of Canals (km)	Year Completed
Ching-hui	Ching Ho	Ching-yang, San-yuan, Kao-ling	730,000	273	1936
Wei-hui	Wei Ho	Mei Hsien, Fu-feng, Wu-kung, Hsing-p'ing, Hsien-yang	600,000	177	1937

Canal	River	Hsiens	Irrigation Area (shih-mou*)	Length of Canals (km)	Year Completed
Lo-hui	Lo Shui	Ta-li, Ch'a-i, Hua-yin	500,000	83	--
Feng-hui	Feng Shui	Hu Hsien, Ch'ang-an, Hsien-yang	230,000	48	1947
Hei-hui	Hei Ho	Chou-chih	160,000	55	1942
Mei-hui	Shih-t'ou Ho	Mei Hsien, Chih-shan	132,000	121	1938
Lao-hui	Lao Ho	Hu Hsien	100,000	22	--
Kan-hui	Kan Ho	Li-ch'uan	30,000	5	1944
Han-hui	Han Shui	Mien Hsien, Pao-ch'eng	110,000	41	1945
Pao-hui	Pao Shui	Pao-ch'eng, Nan-cheng, Ch'eng-ku	140,000	55	1945
Hsü-hui	Hsu Shui	Ch'eng-ku, Yang Hsien	160,000	41	--
Ting-hui	Wu-ting Ho	Huang-shan, Yu-lin	40,000	34	--
Chih-an	Wu-ting Ho	Yu-lin, Mi-chih	11,000	18	1939
Total			2,916,000	973	

/*One shih-mou equals 667 square meters/

The following table presents a list of planned new irrigation projects.

Table 3. New Irrigation Projects /Compiled from figures given in the text/

Canal	Area to Be Benefited (shih-mou)	
Wei-hui No 2	350,000	South of Wei Ho
Yao-hui	130,000	Yao Hsien, Fu-p'ing Hsien
Ch'ing-hui	110,000	San-yuan Hsien
Wei-hui, Sixth Branch	35,000	Wu-kung Hsien
Ning-hui	20,000	Mei Hsien
T'ang-hui	6,000	Mei Hsien
P'ing-hui	43,000	Lung Hsien
Leng-hui	42,000	Nan-cheng Hsien
Total	736,000	

There are 7 million shih-mou of land on both sides of the Wei Ho between Pao-chi and T'ung-kuan in Shensi that could be irrigated. Along the Han Shui another 400,000 shih-mou are irrigable. Two million mou along the Yellow River

in Shensi and Shansi between Lung-men and T'ung-kuan and another million shih-mou of alluvial soil along a number of streams in Shensi could be profitably irrigated. The prospects for extensive expansion of modern irrigation projects in Shensi are very bright.

In addition, there are 464 fairly large-scale old-style irrigation projects in various states of disrepair, involving 29 hsiens in southern Shensi and 15 in the north, drawing water from some 40 streams and capable of benefiting 694,400 shih-mou of land, that should be put into working condition. There are also in existence 1,147 small-scale facilities collectively capable of irrigating 1,474,700 shih-mou. There are 40,213 shallow wells in use for irrigation in 17 hsiens; these wells have a capacity for irrigating 295,721 shih-mou. Putting all these figures and those in above tables together there is a total area of approximately 6,116,821 shih-mou of land in Shensi within reach of existing and planned irrigation facilities.

C. Irrigation in Suiyuan

The most important irrigation area in Suiyuan Province has always been the area of the great bend of the Yellow River commonly called the Ordos. This area is bounded on the east by the Wu-la Shan, on the south of the Yellow River, and on the north by the Wu-chia Ho. It is an area 200 kilometers long from east to west and 70-odd kilometers wide from north to south crisscrossed everywhere by canals carrying water from the Yellow River northward across the plain into the Wu-chia Ho and back through the Wu-liang-su Hai into the Yellow River again. This area was formerly Mongol grazing land, but the pressure of the agricultural population from Shansi and Shensi resulted in the initiation of irrigation during the T'ang Dynasty /618 - 905 AD/.

During the Yuan /Mongol/ Dynasty /1281 - 1368 AD/ the area reverted to grazing land status. In the early years of the Manchu Dynasty /1644 - 1911/, agriculture was revived with considerable success, again attracting a large influx of people from Shansi and Shensi, who expanded the irrigation facilities. Some estimates place the arable land in this area at 16 million shih-mou, of which 10 million can be irrigated. Actually, the area now irrigated is considerably less. The following table shows the present situation with regard to irrigation.

/See table on following page./

Table 4. Comparison of Important Irrigation Canals in the Ordos Area

Canal	Hsien	Canal Length (km)	No of Branches	Area Irrigated in Wet Years (shih-mou)	Area Irrigated in Ordinary Years (shih-mou)	Area Irrigated in Dry Years (shih-mou)
Sui-chi	Lin-ho, Yen-chiang Lang-shan	75	45	600,000	300,000	100,000
Kang-chi	Lin-ho	65	10	50,000	30,000	10,000
Feng-chi	Lin-ho, Yen-chiang	36.5	43	200,000	100,000	50,000
Sha-ho	Wu-yuan, Yen-chiang	42.5	74	1,050,000	60,000	20,000
I-ho	Wu-yuan, An-pei	45	45	200,000	100,000	30,000
T'ung-hai	Wu-yuan, An-pei	57	142	100,000	50,000	20,000
Ch'ang-chi	Wu-yuan, An-pei	65	181	150,000	80,000	35,000
T'a-pu	Wu-yuan, An-pei	60	204	120,000	50,000	15,000
Huang-t'u-la-hai	Lin-ho, Yen-chiang	72.5	--	500,000	250,000	100,000
Yang-chia-ho	Mi-ta'ang	80	65	400,000	250,000	60,000
Min-fu	An-pei	27.5	--	80,000	45,000	25,000
Total		--	--	3,450,000	1,315,000	465,000

In addition to the above canals there are 335 kilometers of smaller canals capable of irrigating 93,000 shih-mou. In 1943, the Fu-hsing Canal was constructed east of the Feng-chi Canal to irrigate 600,000 shih-mou in Wu-yuan and Yen-chiang hsiens. The main canal is 48 kilometers long and enters the Sha-ho Canal. However, only about one fourth of the irrigable land of the area is as yet provided with irrigation facilities.

The flood waters of the Yellow River are not yet being utilized to the fullest possible extent. Because of the changeableness of the Yellow River a great deal of expense is involved in keeping the canal inlets connected with the river year by year and control mechanisms are difficult to maintain. The silt carried in the Yellow River in Suiyuan Province ranges from 0.12 percent to 2.55 percent. Hence silting of the canals is not a great problem.

The terrain in the area is suitable for irrigation having a gradual even slope from south to north and from west to east. The loess soil is very fertile and productive once water is available. The annual variation in water level in the Yellow River in this area is 2-3 meters.

The following table indicates the sequence of water movement in the Yellow River in the Ordos area.

Table 5. Seasons of High Water on the Yellow River in Ordos Area

Rainy Seasons	Time of High Water	Period of High Water (days)		
		Long	Medium	Short
Spring Rains	Before 20 March	10	7	3
Peach Blossom Rains	About 20 April	15	10	7
Warm Rains	About 5 May	30	15	10
Dog Days Rains	June, July	45	30	20
Autumn Rains	August, September, October	60	40	30
Winter Rains	About 7 November	10	6	4

The number of irrigation days per year in this area ranges from 74 to 170 with the average around 108 days. However, spring irrigation water carries considerable alkali. Farmers, therefore, do not like to use it. In the winter the water carries ice which is useful in scouring the canals. The best irrigation water is that of the dog days and in the autumn.

In addition to recent progress in irrigation in the Ordos area of Suiyuan, there has also been progress in the Ch'ien-t'ao area which is northeast of the Yellow River and east of the western tongue of the Wu-la Shan. A split in the Yellow River in this area, the branch being known as the San-hu Ho, encloses some 700,000 mou of arable land. Irrigation facilities in this area are indicated in the following table.

Table 6. Irrigation in the San-hu Ho Area

Canal	Length (km)	Area Irrigated (shih-mou)
Tung-ta	20	50,000
Hsi-kuan	20	60,000
Hsi-ta	10	20,000
Kung-chi	40	20,000
Min-fu	30	10,000
Others	--	2,000
Total		162,000

It is evident from the above figures that only a small portion of the irrigable land in this area is being cared for. If the possibilities of irrigation by use of the water of the Yellow River in Suiyuan Province were exploited to their fullest extent some 12,700,000 shih-mou of land could be benefited. Irrigation is basic to the development of this part of the northwest. Aside from the Yellow River, the Ta-hei Ho and the Hsia-hei Ho, as well as numerous mountain streams and springs, are being utilized by the farmers of Suiyuan for irrigation.

The following table shows the extent of irrigation from such sources.

Table 7. Irrigation in Suiyuan From Sources Other Than Yellow River

Hsien	No of Canals	Area Irrigated (shih-mou)	Remarks
Kuei-sui	132	541,450	Water chiefly from the Ta-hei Ho and the Hsiao-hei Ho
Sa-la-chi	15	81,600	Water chiefly from the Ta-hei Ho
Pao-t'ou	10	2,000	--
Ho-lin	16	60,960	--
T'o-k'e-t'o	4	31,000	--
Ch'ing-shui-ho	11	5,920	--
Chou-yang	18	70,300	--
Wu-chou	5	15,700	--
Chi-ning	3	1,730	Water from Upper Yang Ho
Liang-ch'eng	10	44,500	Water from Upper Yang Ho
Hsing-ho	9	35,000	Water from Upper Yang Ho
Feng-chen	14	19,350	Water from Upper Yang Ho
Total	247	909,510	

The combined irrigation picture for all of Suiyuan is shown in the following table.

Table 8. Present Irrigation Situation in Suiyuan

Canals	Location	Ordinary Seasonal Irrigation Area (shih-mou)
11 Main Canals	Ordos	1,315,000 (Table 5)
32 Minor Canals	Ordos	493,000
Fu-hsing Canal	Ordos	600,000
Main Canals	Ch'ien-t'ao	162,000 (Table 7)
Miscellaneous Canals	Various hsiens	909,510 (Table 8)
Total		3,479,510

If the Min-sheng Canal were again put into working condition another 2 million shih-mou could be added to the area currently irrigated in Suiyuan. If the existing facilities in the Ordos area were modernized, the water supply would become much more dependable and agricultural operations would be far more satisfactory and productive.

D. Irrigation in Ningsia

From the time of the Ch'in Dynasty, each controlling dynasty has carried on irrigation projects in Ningsia. The alluvial soil has always been fertile and productive when irrigated. The province divides naturally into three irrigation areas with a total of 30 million shih-mou of arable land of which at present only 2,700,000 shih-mou are under cultivation.

The following table presents the current irrigation situation in the province.

Table 9. Irrigation Situation on the Ningsia Plains

General Area	Canals	Length (km)	No of Branches	Hsiens	Area Irrigated (shih-mou)
Ho-hsi (West of the Yellow River)	T'ang-lai	212	551	Ho-lan, Yin-chou Ning-shuo, Yung-ning, P'ing-lo, Hui-nung	600,548
	Han-yen	110	436	Ho-lan, Yin-chou, Ning-shing, Yung-ning	345,857
	Hui-ming	184	664	Ho-lan, Yin-chou, Ning-shuo, P'ing-lo, Hui-nung, Yung-ning	396,306
	Ta-ch'ing	37	120	Ning-shuo	59,750
	Ch'ang-lan	43	215	P'ing-lo	65,700
	P'ang-ch'u	30	37	Hui-nung	17,098
	Yung-jun	20	17	Hui-nung	11,136
	Hsi-kuan	24	17	Hui-nung	14,500
	Ma-t'an-chia	4	--	Ning-shuo	12,807
Ho-hsi	Yun-t'ing	60	39	Ho-lan, Yin-chou, Yung-ning, P'ing-lo, Hui-nung	200,000
Ho-tung (East of Yellow River	Ch'in-ch'u	72	1,221	Chin-chi, Lin-wu	186,266
	Han-ch'u	63	250	Chin-chi	133,600
	T'ien-shui	18	72	Ling-wu	26,104
Chung-wei	Mei-li	77	130	Chung-wei	130,865

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	Ch'i-hsing	65	171	Chung-ning	84,548
	Ling-yang-chiao	12	6	Chung-wei	14,486
	Ling-yang-shou	19	7	Chung-wei	11,740
	Ling-yang-chia	24	19	Chung-wei	30,988
	T'ai-p'ing	33	30	Chung-wei	47,678
	Hsin-pei	20	14	Chung-wei	17,260
	Liu-ch'ing	20	47	Chung-ning	19,176
Chung-wei	Hsin-sheng	38	9	Chung-ning	30,495
	Chung-chi	32	69	Chung-ning	20,256
	K'ang-chia-t'an	12	10	Chung-ning	11,103
	Huang-hsin-t'an	10	--	Chung-ning	15,931
	Feng-lo	37	42	Chung-ning	19,750
Total		1,277	4,363		2,545,408

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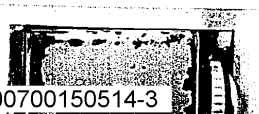

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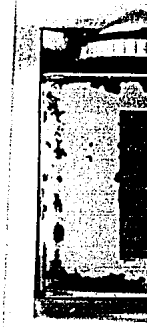


In addition to the above 26 large canals, capable of irrigating over 2,500,000 shih-mou, there are many other canals capable of irrigating under 10,000 shih-mou each. However, the arable area usually irrigated in Ningsia Province is only 1,560,000 shih-mou, and some years as little as 700,000 shih-mou. These facilities, none of which are modern, have the following shortcomings.

1. Poor Drainage System

Poor drainage is especially noticeable in the Ho-hsi area. Drainage is best in the Chung-wei area. Where drainage is poor, water settles in low spots and canals become silted up. Since the water table is high in Ningsia, alkalinity increases because the soil does not leach properly. Much of Ningsia suffers from this difficulty.

2. Faulty Canal Inlet System

Since the movement of the water from the Yellow River into the canal has always depended on gravity there is too great a variation in the supply of water to the irrigation system between times of high and low water. During the flood season a great deal of silt is carried into the canals where it settles and combines with wind-borne soil to clog the canals. Much manpower is required every year to clean the canals.

3. Faulty Canal Locks

The canal locks are not integrated. The system of branch canals should be modernized to insure proper control and saving of labor.

Estimates by various students of the possibilities of irrigation in Ningsia with the introduction of modern methods range from 3 million to 7.5 million shih-mou. For reasons of topography the largest expansion will be possible in the Ho-hsi area. [See Table 9 for names of hsiens.]

The ease with which irrigation can be carried on in Ningsia makes feasible increased cultivation of paddy rice. In the Ho-hsi area most of the paddy rice is grown north of Ho-lan Hsien where some 70 percent of the cereal production is paddy rice. In the remainder of Ho-hsi and in Chung-wei and Ho-tung the average is 30 percent. Cereal farming in local areas is quite specialized, one area grows wheat only, another rice only.

In addition to the irrigation of the Ningsia plain about 100,000 mou are irrigated in the foothills areas.

E. Irrigation in Kansu

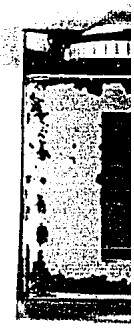
Since the annual rainfall in Kansu runs as low as 100 millimeters, irrigation is a necessity for agriculture and has been practiced for at least 2,000 years. One of the chief sources of irrigation water is the melting snows on the Ch'i-lien Shan.

In Kansu there are three main irrigation areas:

1. Area watered by the Jo Shui, with main centers around Chang-yeh and Kao-t'ai.

2. Area watered by the Lin Shui, centering around Chiu-ch'uan.

3. The Sha-ho and Pai-t'ing Ho irrigation area centering at Wu-wei. Rice can be raised in the areas around Chang-yeh, Kao-t'ai and Lin-tse; in other areas, miscellaneous cereals are raised.



Logging on the Ch'i-lien Shan in recent decades has resulted in elevation of the snow line and serious soil washing on the lower slopes. To completely restore irrigation in the area it will be necessary to reforest these mountains.

Table 10. Irrigation Facilities and Acreage in the Ho-hsi Area of Kansu

Hsien	No of Canals	No of Dikes	Average Rainfall Year Irrigation Area (shih-mou)	High Rainfall Year Irrigation Area (shih-mou)
Yung-teng	10	38	101,600	--
Chi-lang	3	17	75,000	--
Yung-ch'ang	3	35	200,000	300,000
Wu-wei	10	41	255,000	485,000
Shan-tan	8	17	137,300	--
Min-ch'in	16	--	150,000	300,000
Chang-yeh	24	--	266,700	477,700
Min-lo	8	--	164,400	--
Lin-tse	10	--	107,400	--
Kao-t'ai	6	25	194,200	--
An-hsi	6	--	33,300	--
Tun-huang	10	--	120,000	--
Chiu-ch'uan	6	48	200,000	500,000
Yü-men	6	--	12,500	--
Chin-t'a	--	8	50,000	--
Total	126	229	2,067,400	1,762,700

This present area of irrigation is far less than the area once under irrigation. For example, the area now under irrigation in Chin-ch'uan Hsien is no more than one seventh of what it was in earlier and more prosperous times. The other hsiens are in a similar situation. One of the main defects in the present obsolete canal system is the lack of inlet controls. For various reasons, including stagnation and evaporation in the old canals, only about one sixth of the available water is actually used in irrigation. Without control, the snow-water supply is unseasonable and the result is a very inefficient usage thereof. There have been long standing feuds among the various hsiens over water rights.

The best practicable solution of the difficulties is the construction of suitable flood water reservoirs in the upper reaches of the streams to effect an even distribution of the available supplies. Simultaneously scientific repair and reconstruction of the Ho-hsi canal system should be carried out. It will then be possible to expand considerably the area under effective irrigation. A great expansion of the system of shallow wells is also possible in the area. The water table stands at from 10 feet to several tens of feet below the surface in much of the area. Such wells can care for the irrigation needs of 30 mou each.

There is a certain amount of modern irrigation activity in Kansu in the valley of the Yellow River and its tributaries. The terrain places certain natural strictness on irrigation, most of the arable land consisting of long narrow strips along the banks of the streams. The following table shows some of the modern irrigation developments:

Table 11. New-Type Irrigation in Kansu

Canal	Area	Water Source	Length of Canal (km)	Irrigated Area (shih-mou)	Year Completed
T'ao-hui	Lin-t'ao	T'ao Ho	28.3	27,000	Aug 1938
Huang-hui	Kao-lan, Yung-teng	Huan Shui	31.0	25,000	Apr 1942
Po-chi	Lin-t'ao	T'ao Ho	19.3	35,000	Apr 1942
Jui-feng	Ching-chou	Jui Ho	13.1	10,000	Mar 1944
Yung-feng	Yung-ching	Huang Ho	25.3	23,000	Dec 1944
Yung-lo	Yung-ching	Ta-sha Ho	17.0	48,000	Dec 1944
Ching-feng	Ching-yuan	Yellow River	15.6	20,000	Dec 1944
Lan-feng	Kao-lan	Yellow River	75.1	110,000	--
Teng-feng	Yung-teng	Ta-t'ung Ho	--	4,500	Apr 1946
Hsiao-feng	Chin-ch'uan, Chin-t'a	Lin-shui	--	70,000	May 1947
P'ing-feng	P'ing-yuan	Ching Ho	83.5	80,000	--
Total				452,500	

Because of the terrain the construction of the above irrigation works has been difficult and there is little opportunity for expansion. In the eastern and southern parts of Kansu there is a large network of old-style canals. They are listed in the table below.

Table 12. Old-Style Irrigation Facilities in East and South Kansu

Hsien	Water Source	No of Canals	Area Irrigated (shih-mou)
Kao-lan	Shan-chien Shui	13	36,300
Ching-yuan	Tsu-li Ho	9	21,000
T'ao-sha	T'ao Ho	10	15,600
Lin-t'ao	T'ao Ho	12	200,000
Min Hsien	T'ao Ho	1	20,000
Ning-ting	T'ao Ho	2	250,000
Wei-yuan	Wei Ho	4	6,000

Hsien	Water Source	No of Canals	Area Irrigated (shih-mou)
Wu-shan	Wei Ho	3	8,600
Lung-hsi	Wei Ho	6	23,900
Chang Hsien	Wei Ho	1	20,000
Ch'in-an	Wei Ho	8	3,000
Kan-ku	Wei Ho	1	5,000
T'ien-shui	Wei Ho, Chi Ho, Yung Ch'uan	5	4,600
Li Hsien	Chia-ling Chiang	1	1,000
K'ang Hsien	Chia-ling Chiang	1	2,000
Hui Hsien	Chia-ling Chiang	1	3,000
Wen Hsien	Pai-lung Chiang	5	11,000
Ch'eng Hsien	Chia-ling Chiang	1	2,000
Wu-tu	Pai-lung Chiang	5	10,000
Ting-hsi	Nan-pei Ho	2	7,900
Hui-ning	Tsu-li Ho	4	1,500
Ching-t'ai	Shan-ch'ien-shui	1	2,000
Hai-yuan	Ch'ing-shui Ho, Shan-chien-shui	7	12,200
Yü-chung	Ta-ying Ho, Ch'uan Shui	2	40,000
Ching-ch'uan	Ching Ho	1	400
Ping-liang	Ching Ho	6	320,000
Cheng-ning	Ching Ho	2	200,000
Lin-hsia	Ta-sha Ho, Wei-chia-chi Ho	20	37,000
Cheng-ning	K'u-shui Ho, Hu-lu Ho	6	10,000
Hung-shui	--	2	3,500
K'ang-lo	T'ao Ho	2	8,000
Total		144	1,285,500

Another type of irrigation practiced along the Yellow River is pump irrigation utilizing the water of the river. The following table gives 1944 figures on this type of water supply.

Table 13. Pump Irrigation in Kansu

Hsien	No of Pumps	Area Irrigated (shih-mou)	Average Area Irrigated by Each Pump (shih-mou)
Kao-lan	203	55,926	275
Yung-ching	69	17,120	249
Ching-yuan	59	15,595	264
Yü-chung	19	5,200	274
Ching-t'ai	9	1,845	205
Hui-ning	2	600	300
Total	361	96,280	--
General Average			211.3

Although a sizeable amount of land has been irrigated by these water-driven pumps, their initial expense, upkeep, and limitations on their usefulness at both high- and low-water seasons makes any considerable expansion of their use unlikely. The following table summarizes the present irrigation situation in Kansu.

Table 14. Present Over-All Irrigation Situation in Kansu

Type	Area Irrigated (shih-mou)	Remarks
Old-Type Irrigation (Ho-hsi area)	2,067,100	Table 11
New-Type Irrigation	452,500	Table 12
Old-Type Irrigation (East and South Kansu)	1,285,500	Table 13
Pump Irrigation (Yellow River)	96,280	Table 14
Well Irrigation (various hsiens)	70,000	--
Small-Scale Irrigation	130,000	--
Total	4,101,380	--

F. Irrigation in Tsinghai

The mountainous terrain in much of Tsinghai and the essentially grazing nature of the Tsaidam Basin, leave only a small portion of the eastern part of the province suitable for agriculture. This area is essentially dependent on irrigation. Most of the present irrigation development is in the Huang Shui valley with some in the Yellow River valley.

The following table indicates the extent of old-style irrigation in Tsinghai.

Table 15. Old-Style Irrigation in Tsinghai

Area	No of Canals	Area Irrigated (shih-mou)
Hsi-ning	21	145,250
Huang-yuan	20	37,380
Lo-tu	36	72,060
Kuei-te	12	80,930
Wu-chu	8	150,900
Tun-hua	12	15,000
Hua-lung	7	11,700
Min-ho	30	20,820
Tung-jen	7	4,560
Ta-t'ung	4	61,200
Kung-ho	16	28,000
Tu-lan	8	9,300
Wei-yuan	2	12,000
Yu-shu	3	9,000
Nang-ch'ien	3	9,000
Ch'i-ti	--	35,000
Total	189	702,850

The urgent need for increased food production during the war against Japan led to the development of four modern-type canals and considerable government assistance to small-scale irrigation. This is shown in the following table.

Table 16. Modern Irrigation Facilities in Tsinghai

Canal	Area	Length (km)	Year Completed	Area Irrigated (shih-mou)
Fang-hui	Hu-chu	23	Nov 1947	13,000
Ch'ü-ko-ho	Kuei-te	40	1942	2,000
T'ang-nai-ho	Hsing-hai	10	1946	5,500
Lu-ts'ang	Kuei-te	25	1946	35,000
Small-scale irrigation	--	--		7,660
Total		98		63,160

Due to both terrain and climate in Tsinghai the possibilities for expansion of irrigation outside the present area are very limited indeed.

G. Irrigation in Sinkiang

Most of the agriculture of Sinkiang is carried on at oases -- grassland oases in the north and desert oases in the south. These oases depend largely on melting snow from the mountains for their water supply. This fact results in a very heavy population per square kilometer in oases, as high as 320 persons in some cases. From time immemorial, human activity in Sinkiang, particularly in the southern part, has been dependent upon irrigation. The future development of Sinkiang requires that even greater stress be placed on irrigation. Approximately one-half of the population in the Turfan Depression is dependent on another type of irrigation, namely, tunnel irrigation. In the Ha-mi area about one fourth of the population depends on this type. In Tu-lu-fan, Tu-shan, and T'o-k'o-sun hsiens the irrigation capacity of tunnels varies from 300 to 1,000 shih-mou each, according to size; but in the Ha-mi area the average capacity is 40 shih-mou. This method of irrigation is, however, expensive, both in initial cost and in upkeep. The method of construction is to dig a canal from the plain toward the hills and then continue with a horizontal tunnel into the mountain side until a water-bearing stratum is reached from which water will flow through the tunnel into the canal. The tunnels may be anywhere from a few rods to several kilometers long. At intervals of 30 to 40 feet perpendicular wells are dug from the surface of the ground to the tunnel to provide ventilation and a means of cleaning silt or other obstructions out of the tunnel.

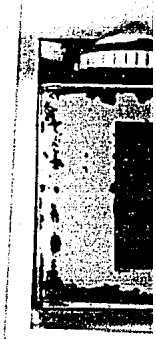
The paucity of rainfall in Sinkiang makes agriculture largely dependent upon the melting snow of the various mountain ranges. Therefore, the larger part of the agricultural population is distributed along the foothills of the various mountain ranges.

The following table indicates the old-type irrigation facilities of the province.

Table 17. Old-Style Irrigation Facilities in Sinkiang

Hsien	No of Canals	Length (km)	Area Irrigated (shih-mou)
Ti-hua	68	1,038	160,290
Fou-k'ang	20	242	76,512
Ch'ien-te	21	154	67,475
Fu-yüan	23	633	121,753
Chi-t'ai	24	750	183,400
Hu-t'u-pi	3	80	69,560
Mu-lei-ho	5	48	26,500
T'o-k'o-hsün	2	180	35,740
Tu-lu-fan	2	150	254,524
Shan-shan	8	79	56,400
Ch'ang-chi	8	400	111,991
Sui-lai	9	176	154,912

Hsien	No of Canals	Length (km)	Area Irrigated (shih-mou)
I-ning	13	163	989,419
Sui-ting	11	252	243,000
Wen-ch'üan	45	1,410	37,040
Po-lo	21	194	25,174
Ching-ho	10	271	77,357
Chao-su	5	51	30,000
Kung-liu	14	2,260	289,665
Kung-ha	55	1,995	91,437
Ho-ch'eng	9	180	206,214
Ho-nan*	12	324	236,454
T'e-k'o-ssu	7	400	70,000
Hsin-yuan*	14	146	52,741
T'a-ch'eng	76	404	78,960
O-min	18	285	13,270
Yü-min She-chih-ch'ü*	121	1,888	4,820
Sha-wan	23	190	54,584
Wu-su	9	720	71,540
Ho-feng She-chih-chü*	2	150	1,075
Ch'eng-hua	31	1,790	60,000
Fu-yün	3	180	6,285
Fu-hai	4	56	12,000
Ha-pa-ho	12	113	2,521
Chi-mu-nai	10	150	16,225
Ch'ing-ho	5	125	2,380
Pu-erh-ching	21	69	10,912
Ha-mi	6	114	60,410
Chen-hsi	32	319	53,525
I-wu	8	233	11,281



Hsien	No of Canals	Length (km)	Area Irrigated (shih-mou)
Yen-ch'i	27	1,215	10,000
Ho-ch'ing* /Possibly an error for Ho-ching/	5	114	270,000
K'u-erh-lo	17	325	198,000
Ch'ieh-mo	4	140	75,000
Lun-t'ai	21	199	211,700
Wei-li	10	346	71,012
Ch'o-chiang	20	810	23,200
Ho-shih She-chih-chu	3	95	11,155
A-k'o-su	15	750	619,265
Wen-su	20	1,010	474,640
K'u-ch'e	102	2,015	490,583
Pai-ch'eng	17	435	490,356
Wu-shih	25	1,005	445,237
Sha-ya	52	1,446	632,064
A-wa-t'i	30	605	241,201
K'o-p'ing	2	53	5,107
Hsin-ho	11	395	577,207
A-ho-ch'i She-chih-chu*	3	175	13,962
Su-fu	32	627	443,815
Su-lo	4	573	545,089
Yüeh-p'u-hu	11	185	175,780
Chieh-shih	17	180	86,200
Ying-chi-sha	4	201	524,927
Wu-ch'ia	5	285	57,400
Pa-ch'u	50	275	300,000
A-t'u-shih	10	615	87,420
P'u-li	3	184	29,800
So-ch'e	10	1,056	562,488

Hsien	No of Canals	Length (km)	Area Irrigated (shih-mou)
Yarkand	82	770	1,261,958
Tse-p'u	64	473	194,000
Mai-kai-t'i	49	545	290,102
Yeh-ch'eng	20	800	1,200,000
Ho-tien	43	315	290,000
Yu-tien	7	180	372,120
Lo-p'u	12	240	425,900
Mo-yü	11	400	441,000
Pi-shan	60	947	509,262
Ts'e-lo	25	1,016	161,055
Total	1,584	39,360	16,992,335

/*Not found in available gazetteers/

From the above table it is apparent that practically all the hsiens in Sinkiang have some irrigation activity, and these irrigation facilities are indeed indispensable for the continued existence of the population. However, the present facilities leave much to be desired in quality.

The present system lacks flood control facilities, silt prevention, and leak prevention facilities.

The most important requirement for the success of irrigation at present is for reservoirs to store up the excess snow water of late summer so that it can be released under control when needed later. It is particularly needed in the spring and early summer.

During recent years, 15 new modern irrigation projects have been completed, as shown in the following table.

Table 18. Recently Constructed Modern-Type Irrigation Facilities in Sinkiang

Project	Area	Water Source	Area Irrigated (shih-mou)	Date Completed
Hung-yen-ch'ih Reservoir	Ti-hua	Wu-lu-mu-chi Ho	45,000	1943
Chin-yung Canal	Ti-hua	Hung-yen-chih Reservoir		
T'ien-ch'ih Reservoir	Fou-k'ang	Po-k'o-ta mountain ravines	22,500	1943
Lin-Yün-hu Canal	Fou-k'ang	T'ien-ch'ih Reservoir		

Project	Area	Water Source	Area Irrigated (shih-mou)	Date Completed
Hsin-sheng Canal	Sha-wan	Ma-na-ssu Ho	90,000	1944
Ch'ing-shui Ho-tzu Canal	Sui-lai	Ch'ing-shui Ho-tzu	7,500	1941
Ta-yü Agricultural Canal	I-ning Sui-ting	K'o-shih Ho	326,000	1930
Hsiao-yü Agricultural Canal	I-ning	K'uei-t'un Ho	126,400	1943
Tu-shan-tze Canal	Wu-su	K'uei-t'un Ho	15,000	1943
T'u-erh-man Canal	Yen-ch'ih	Tu-erh-man-p'o Ho	75,000	1943
Shih-ch'eng-tzu Canal	Ha-mi	Shih-ch'eng-tzu Ho	30,000	1943
A-wei-t'an Canal	Ch'eng-hua	K'o-la-yin Ho	45,000	1943
A-erh-t'u-shih Diversion Lock	Shu-fu	A-erh-t'u-shih Ho	135,000	1942
K'u-erh-kan Ho Diversion Lock	Shu-fu	K'u-erh-kan Ho	225,000	1941
Hung-hai Reservoir	Pa-ch'u	So-ch'e Ho	330,000	1942
Chin-yung Canal	Mai-kai-t'i	So-ch'e Ho	105,000	1941
Total			1,577,400	

Although these new irrigation facilities are of a modern type, they suffered in their development from the fact that, because of the urgency of war necessity, not enough careful engineering practice was employed in their construction.

The most important item in this group of irrigation facilities is the Hung-yen-ch'ih detention basin project that was begun in 1941 with an initial capacity of 19 million cubic meters. This basin collects autumn and winter water from the Wu-lu-mu-ch'i Ho, when it is not needed for irrigation, as well as summer flood waters. A 6-kilometer canal carries the water from the river to the detention basin. A 3-kilometer canal carries the water from the basin into the Chin-yung irrigation canal system for distribution to fields.

The second largest reservoir in Sinkiang is the T'ien-ch'ih Reservoir in Fou-k'ang Hsien. This is a natural reservoir, approximately one kilometer by 2 kilometers in size at an elevation of 1,800 meters above sea level. It has an area of 2,400,000 square meters and is capable of impounding 150 million cubic feet of water. However, the annual natural intake only amounts to about 38 million cubic meters, of which 20 to 25 million cubic meters soaks away; the rest flows out through a breach in the eastern perimeter. The height of the water level varies by about 10 meters through the summer season. By means of a dam and control lock, placed at the natural outlet in 1942, some 22,500 shih-mou of fields were provided with irrigation.

Estimates already made indicate that if reservoirs and detention basins were constructed in strategic locations in sufficient numbers to impound and control the snow waters of the mountain ranges, some 17 million shih-mou could be added to the irrigated area of Sinkiang Province.

H. Irrigation and Crop Production in Northwest

The arid climate of the Northwest has made irrigation necessary in most of the area from time immemorial. It is still necessary for the continued existence of any human population.

The following table reveals the ratio of regularly irrigated land to the total area.

Table 19. Ratio of Irrigated Land in the Northwest to Total Area By Provinces

Province	Land Area (sq km)	Land Area (shih-mou)	Irrigated Area (shih-mou)	Percentage of Total Area
Shensi	187,909	281,863,400	4,686,400	1.66
Suiyuan	329,397	494,055,500	3,579,510	0.72
Ningsia	233,320	349,980,000	1,600,000	0.46
Kansu	391,506	587,259,000	4,101,380	0.70
Tsinghai	667,236	1,000,854,000	765,260	0.07
Sinkiang	1,711,931	2,567,896,500	18,622,726	0.72

(Land Area Statistics From the Monthly Publication of the Former Bureau of Statistics No 23 and 24)

Table 20. Ratio of Irrigated Land to Cultivated Land in the Northwest

Province	Cultivated Area (shih-mou)	Irrigated Area (shih-mou)	Percentage of Cultivated Area
Shensi	45,627,000	4,686,400	10.3
Suiyuan	17,066,000	3,569,510	20.9
Ningsia	2,700,000	1,600,000	59.3
Kansu	26,167,000	4,101,380	15.7
Tsinghai	7,807,000	765,260	9.8
Sinkiang	19,631,970	18,622,726	94.9

The superiority of canal irrigation systems over other systems is illustrated by a comparison of production figures for canal-irrigated and noncanal-irrigated land in the Kuan-chung area of Shensi as shown in the following table.

Table 21. Comparison of Crop Production in Canal-Irrigated and Noncanal-Irrigated Areas in Shensi

Canal Area	Crops	Production per Mou on Noncanal-Irrigated Land	Class of Irrigation	Production per Mou on Canal-Irrigated Land	Excess of Production per Mou on Canal-Irrigated Land over Noncanal-Irrigated Land
Ching-hui Canal	Wheat	6 shih-tou*	1	16 shih-tou	10 shih-tou
	Wheat	6 " "	2	14 " "	8 " "
	Cotton	20 shih-chin**	1	80 shih-chin	60 shih-chin
	Cotton	20 " "	2	60 " "	40 " "
	Cotton	20 " "	3	40 " "	20 " "
Wei-hui Canal	Corn	8 shih-tou	1	33 shih-tou	25 shih-tou
	Corn	8 " "	2	20 " "	12 " "
	Corn	8 " "	3	13 " "	5 " "
Kan-hui Canal	Cotton	25 shih-chin	1	60 shih-chin	35 shih-chin
	Cotton	25 " "	2	45 " "	20 " "
Mei-hui Canal	Corn	6 shih-tou	2	16 shih-tou	10 shih-tou
	Corn	6 " "	3	10 " "	4 " "
	Paddy rice	8 " "	1	20 " "	12 " "
	Paddy rice	8 " "	2	15 " "	7 " "
	Paddy rice	8 " "	3	10 " "	2 " "
Hei-hui Canal	Corn	6 shih-tou	1	26 shih-tou	20 shih-tou
	Corn	6 " "	2	16 " "	10 " "
	Corn	6 " "	3	10 " "	4 " "
	Paddy rice	8 " "	1	20 " "	12 " "
	Paddy rice	8 " "	2	15 " "	7 " "
	Paddy rice	8 " "	3	10 " "	2 " "

[*One shih-tou equals 10 liters]

[**One shih-chin equals 1/2 kilogram]

During 1947, the production of ginned cotton in the Ching-hui canal area increased by 218,000 shih-tan [one shih-tan equals 110.23 pounds] and food crop production by 234,000 shih-shih [one shih-shih equals 100 liters dry measure]. In the Wei-hui canal area the production of ginned cotton increased by 32,000 shih-tan and food crops by 280,000 shih-shih. Comparable gains were made in the other canal areas. The addition of irrigation facilities in the Lan-feng canal area in Kansu will result in an increase in wheat production of 127,000 shih-shih on 110,000 shih-mou of land.

The prospects of increasing the irrigated areas of the Northwest are as follows:

Province	Area of Possible Increase (shih-mou)
Sinkiang	17,000,000
Ningsia	2,400,000
Suiyuan	10,000,000 (including 2 million shih-mou in the Min-sheng canal area)
Shensi	736,000

According to some estimates if all the lateral areas of the rivers of the Northwest that are not now irrigated were irrigated, another 10 million shih-mou would become productive. With the proper expansion of irrigation projects in the Northwest, some 43,400,000 shih-mou can be added to the cultivated area, providing for an increase of about 8 million in population on the basis of 5 shih-mou per person.

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